lites like the well-known Henry mountains, plutonic plugs of which there are several examples in the vicinity of the Black Hills, and deeply-seated intrusions of a viscous magma which raised vast domes of sedimentary rock with the floor of metamorphic rock on which they rested as the whole Black Hills dome, Big Horn and Park mountains. As to the cause of these uplifts, nothing less than the force exerted by a cooling globe is thought to be adequate. That they took place very slowly is inferred from the fact that fracture did not result from the bending of thousands of feet of strata. That these domes are in the interior of the continent rather than near the coast is because here the crust is relatively light and strata are horizontal, hence pressure on the plastic interior due to contraction of crust or to transfer of material on the surface would be most likely to produce domes.

Deformation of Rocks: By C. R. VAN HISE. This is the first of a series of papers on the same subject to be published in the *Journal* as 'Studies for Students.' The author divides the outer part of the earth into three zones: (1) An upper zone of fracture; (2) a middle zone of fracture and plasticity; (3) a lower zone of plasticity. Rocks under less weight than their ultimate strength when rapidly deformed are in the zone of fracture. The maximum depth at which fracture can take place is thought to be 10,000 meters. Rocks below this are in the region of plasticity and flowage. Since flowage is necessary to folding, closely folded strata were generally buried beneath other strata. The boundary between the zone of fracture and that of flowage is at different depths for two rocks of different strength, also for the same rock under different conditions of stress, hence there is a zone of combined fracture and flowage. This is thick and of prime importance. In heterogeneous strata in this zone, irregular fracturing, brecciation, jointing, faulting, folding, and development of secondary structures, may occur together in a most complex manner. Between the three zones there are many gradations.

Chas. R. Keyes contributes a careful and appreciative review of Wachsmuth and Springer's new book, *North American Fossil Crinoidea Camerata*. Several reviews and authors' abstracts of current geological literature follow.

SOCIETIES AND ACADEMIES.

GEOLOGICAL CONFERENCE OF HARVARD UNIVERSITY, MARCH 10, 1896.

An elementary presentation of the tides: BY W. M. DAVIS.

The object of this communication is to show how the tides may be treated in an essentially scientific manner in an elementary collegiate course on physiography. The facts are presented by means of tracings from selected automatic records of tide gauges in the Coast Survey office, for stations in mid-ocean (Honolulu), Pacific coast (Port Townsend, Wash.), Atlantic coast (Boston), and in estuaries (Delaware at Philadelphia, and lower Seine, the latter from French records). Mean interval of tides, and systematic variation of interval and of range are numerically determined from these records by the students in laboratory exercises. The agreement of the mean interval with half a lunar day suggests that the moon and the tides may be related in some way as cause and effect. Inquiry is then made as to the manner in which the moon could cause periodic oscillations of the ocean.

The dimensions, distance and movements of the earth and moon being given, the deforming forces due to lunar attraction, situated as it were on a shell enclosing the earth, are worked out quantitatively in terms of gravity, according to the law of gravitation. A tide opposite to the direct lunar tide, often regarded as an obscure part of the problem, is seen to be as essential a consequence of the theory as the direct tide itself. The first simple supposition of a moon moving in a circular orbit in the plane of the earth's equator is afterwards changed to the actual condition of the moon moving in an orbit of considerable eccentricity and in a plane oblique to the equator; thus introducing expectations of various systematic inequalities in tidal intervals and ranges. The essential features of diurnal inequality are simply illustrated as a necessary consequence of theory by means of a 'tidal globe,' rigged with appropriate circles for high and low tides. Solar tidal forces and

their combinations with lunar forces are easily calculated to a sufficient degree of detail.

Although the forces available for the deformation of the ocean are so small that the student may at first doubt their sufficiency as a cause of the observed tides, his doubts vanish when the consequences of the theory are systematically confronted with the generalized results of observation, and the extraordinary agreements of the two are discovered. Although a fairly complete record of facts may be made by the average college student in the early laboratory exercises, it is nearly always the case that some classes of facts will escape his first scrutiny of the tidal curves and will be revealed only when attention is called to them by the expectations of theory. Due attention is thus paid to the different kinds of verification of theory. The final acceptance of the theory becomes a logical necessity, independent of the will, even though certain features of the tides, especially of the Atlantic tides, remain beyond the reach of the elementary discussion here attempted.

The treatment of the open-ocean tide and the onshore tide, as comparable to offshore swell and on-shore surf, suffices to explain various facts as to age and range; and the treatment of the on-shore tide as a wave accounts for the peculiar relations often observed between flood and ebb currents and high and low water. It is on the basis of work of this kind that the claim is made of the essentially scientific quality of physiography. Although other divisions of the subject may not be dealt with mathematically, they all contain the logically successive phases of observed and generalized facts, postulated general principles, provisional hypotheses, consequences or expectations deduced from the hypotheses, comparison of the consequences with the facts, and final evaluation of the knowledge gained. Lunar gravity is the main force causing the tidal changes of the sea; terrestrial gravity is the main force causing the slower physiographic changes of the land.

Tidal Scour: By F. P. Gulliver.

The speaker considered the forms produced by the tides upon flat coasts and pointed out that it is wholly a question of ratios that determines the form in any given locality. He did not agree with Mr. Shelford that deltas are produced only in tideless seas,* for there are weak tides even in the Gulf of Mexico, where the Mississippi mouths, and in the Mediterranean, where the Nile and Tiber deltas are found, while the Ganges produces its delta in the face of seventeen-foot tides. If the river is relatively stronger than the tides and other sea forces it will build forward a delta.

It is also largely a question of ratios between the on- and offshore action and the alongshore action which determines the production of broken or continuous shore lines. Where there is a broad area of marshes and flats, upon which the water lies at high tide, and then during the ebb scours runways beneath the level of the flats, it is inferred that the tidal action is the process which determines the shore forms. Off steeper coasts less tidal action is indicated. Where the shoreline is prevailingly longitudinal a ratio in favor of alongshore action is inferred.

A graded series of shore forms was shown, from that in which the pure tidal on- and offshore action is indicated to that in which the alongshore action seems to be dominant. The type of the tidal action was on the west coast of Florida, where the tides are weak, but indications of alongshore action are absent, therefore the ratio is greatly in favor of the tides. The runways are of the indefinite consequent or autogentic type of drainage, and the shoreline is minutely irregular without deep indentations. The salt marsh grades into the tidal flat.

The type of the dominant alongshore action was taken from the Texas coast. An offshore bar here forms a long gently swinging curve extending for 102 miles unbroken by a single tidal inlet. This bar appears to have an outline dominated by alongshore action.

Along the coasts of the world various combinations of different absolute values of these two actions may be seen in varying ratio. Where the values are larger the forms have greater vertical measure, as in South Carolina and in the Schleswig-Holstein region. The following series of maps was shown, illustrating the progressive change in ratios between the

* Min. Proc. Inst. Civ. Engin., LXXXII., 1885, 2–68.

tidal on- and offshore and the alongshore actions:

I. West coast of Florida (Coast Survey, 180, 181).

II. West coast of Schleswig-Holstein (Topographical map of the German Empire, 1:100,000, 5, 11, 20, 21, 35, 36, 37, 55, 56, 79, 80, 109, 110,111).

III. Georgia-South Carolina coast (Coast Survey, 152, 153, 154, 155, 156).

IV. North Carolina and New Jersey coasts (Coast Survey, 148, 149; 123).

V. New Jersey, Virginia, North Carolina coasts (Coast Survey, 122; 138; 145, 146, 147).

VI. Texas coast (Coast Survey, 210, 211, 212).

MARCH 17, 1896.

1. *Exhibition of New Lantern Slides*, by J. B. WOODWORTH.
2. *Note on Penning's Field Geology*, 2d. edition, reissue of 1894, by T. A. JAGGAR, JR.

This book (published by Bailliere, Tindall and Cox, London) and A. Geikie's 'Outlines of Field Geology' (Macmillan, 1891) are the only books known to the writer which purport to deal with practical field methods of geology. Geikie's book is more popular in style, more elementary and more comprehensive; his chapter on the schistose rocks is excellent, while Penning does not even mention them. Penning's book, on the other hand, contains many useful tables, rules for finding true dip, tracing boundary lines and faults, levelling etc. The directions for note taking do not include mention of the coördinate method of designating points on the note-book map, nor is the use of the plane-table mentioned; in these and other respects the book is not up to date for the American geologist, but on the whole the part which deals with geological surveying, sections and levelling contains much that is useful. The part devoted to paleontology by Jukes-Browne contains many useful hints for the collector, and tables of fossils that are of course intended for use in British fields. Part V. is suggestive, dealing with some difficulties likely to be encountered by the student in the field, notes on water supply, springs and wells; stress is laid on the great importance of the study of physical features in connection with geological structure. The weakest chapter in the book is that devoted to lithology, which gives elaborate and antiquated tables of physical tests for minerals, rocks and ores, but does not touch on the difficulties likely to beset the student in the field. Mr. Penning believes "it should be unnecessary to insist upon what all geological text-books so strongly recommends, that an acquaintance with the appearance and characteristics of all ordinary rocks and minerals should be formed by careful study of cabinet specimens." He believes that "tests applied in their proper order," according to his tables, "will go far enough to arrive at an accurate solution." Rutley's 'Study of Rocks' (1879) is quoted as 'an important work, recently published,' while in the lithological bibliography no mention is made of such books as Teall's 'British Petrography' or the English translation of Rosenbusch.

T. A. JAGGAR, JR.,
Recording Secretary.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 450th meeting was held on March 14, 1896. The paper of the evening was read by Hon. Carroll D. Wright, Commissioner of Labor. on 'The Factory System as an Element in Civilization,' showing that the factory elevates the low class of persons which it employs by compelling them to think more and be more orderly and careful than they otherwise would.

BERNARD R. GREEN,
Secretary.

THE TORREY BOTANICAL CLUB, MARCH 25, 1896.

IN the absence of the President the chair was occupied by Dr. T. H. Allen, first Vice-President, and there were present 39 persons.

Two new members were elected, and W. A. Bastedo appointed to act as Secretary during the absence of Dr. Rusby in South America.

As the summer season is now rapidly approaching, a 'Field Committee,' with Dr. N. L. Britton as chairman, was appointed to arrange for the weekly outings of the club.

The announced paper on Azaleas was postponed owing to the unavoidable detention of Mr. H. A. Siebrecht in the Island of Trinidad.

A new fascicle of the 'Distribution of North American Algæ,' by Collins, Holder and Set-

chell was shown and commended by Dr. Britton. Also a sedge *Reimaria maritima*, only lately found in Florida at Lake Worth, but having a wide distribution elsewhere.

The announced paper for the meeting was read by Miss Alexandrina Taylor, entitled 'A comparative Study of the superficial Periderm in a number of species of Salix,' and was well illustrated by diagrams. In most text-books the work of Sanio is taken as authority on the development of superficial periderm. From the large number of species of the genus Salix, he selected one as a type. The many variations from this type pointed to the possibility that, by extending the study over a greater number of species than those studied by Sanio, one might be found which might more justly be called the type of the genus. This was the object of the above study.

W. A. Bastedo,
Recording Secretary pro tem.

WEST VIRGINIA ACADEMY OF SCIENCE.

The fifteenth regular meeting of the Academy, which was also the first annual session of the organization, was held at Morgantown, March 24, 1896.

The following officers were reëlected:

President, Dr. A. D. Hopkins; Vice-President, Prof. Thos. C. Miller; Secretary and Treasurer, Mr. W. Earl Rumsey; Corresponding Secretary, Prof. B. H. Hite.

The President, in referring to the history and first year's work of the Academy, stated that the Academy was organized on February 25, 1895, with sixteen active members and twelve associate members, representing chemistry, physics, geology, biology, entomology, mechanical and civil engineering, zoölogy, medicine, agriculture, horticulture and general science.

Fourteen regular sessions of the Academy have been held, twenty-eight communications have been presented, and three important resolutions have been passed. The communications referred to the following subjects and branches of science:

Chemistry, 1; psychology, 3; electricity, 2; geology, 1; horticulture, 2; bibliography, 2; agriculture, 2; entomology, 2; mechanical engineering, 3; ornithology, 2; general science, 1; anthropology, 1; botany, 1; civil engineering, 1; hydrography, 2; forestry, 2.

The resolutions were with reference to the publication of topographic maps, waterways and forest preservation.

The only communication presented at this meeting besides the President's remarks was by Prof. L. C. Corbett, who announced the completion and successful test of an improved *auxanometer*, which was exhibited at work. In explanation Prof. Corbett stated that the chief features of the machine are that all parts of the instrument are mounted upon a rigid base; the usual system of proportionate pulleys has been replaced by a simple lever of the first type, *i. e.*, where the fulcrum is between the power and the weight. The record is made in ink upon a paper-bound cylinder. The rate of the cylinder is retarded to a single revolution in 24 hours. The record of each day, therefore, appears as a platted curve rather than in the form of a spiral, as is the case with recording drums making a revolution each hour. The mode of attaching the *auxanometer* to the plant has been improved upon by substituting wooden forceps with relatively broad faces for the usual bent pin; this is again connected with the recording arm of the instrument by a fine wire instead of the usual cord. In this way the objectionable features of the system of weighted cords and pulleys are overcome.

W. Earl Rumsey,
Secretary.

NEW BOOKS.

A Compendium of General Botany: Max Westermaier, translated by Albert Schneider. New York, John Wiley & Sons. Pp. x+299.

Natural History of Selborne: Gilbert White, with an Introduction by Edward S. Morse. Boston and London, Ginn & Co., 1896. Pp. xii+251.

The Psychology of Attention: Th. Ribot, third revised edition. Chicago and London, Open Court Publishing Co. 1896. Pp. xii+120.

An Examination of Weismannism: George John Romanes. Chicago and London, The Open Court Publishing Co. Pp. ix+221. 35 cts.